Paper A 8

FOREST AND LAND INVENTORY USING ERTS IMAGERY AND AERIAL PHOTOGRAPHY IN THE BOREAL FOREST REGION OF ALBERTA, CANADA

C. L. Kirby*

Satellite imagery and small-scale (1:120,000) infrared ektachrome aerial photography for the development of improved forest and land inventory techniques in the boreal forest region are presented to demonstrate spectral signatures and their application. The centre point of the study area is at 57°N and 118°W (Figure 1).

The forest is predominately mixed, stands of white spruce and poplar, with some pure stands of black spruce, pine and large areas of poorly drained land with peat and sedge type muskegs. This work is part of coordinated program to evaluate ERTS imagery by the Canadian Forestry Service.

Figure 2 is a satellite scene obtained by the multispectral scanner of ERTS on September 2, 1972. The scene has been geometrically and radiometrically corrected. Mapping precision of this satellite frame is similar to that obtainable on a national topographic map at a scale of 1:250,000 (50 meters), and serves as a useful base map—because of the detail—for transferring information from the small-scale aerial photography. The green, red and first infrared bands have been combined with an electron beam image recorder by the Canada Center for Remote Sensing in Ottawa to produce a false color picture somewhat similar to that obtained with small-scale (1:120,000) aerial photography.

Geological and hydrological features that the satellite picture brings out are: areas of sand dunes (a dead ice moraine) (1), beach lines and glacial spillways (2) (3), and lakes filled with algae and sedges (4). An inventory of all ponds giving not only location but also water quality is possible. Interpretation such as this, over time, will clearly indicate the direction of many hydrologic processes. Water with algal growth and tall sedges because of the high I. R. reflectance, appears light pink. Water with high amounts of sedimentation, such as the Peace River, shows as blue. The sand bars in the Peace River have a high reflectance and appear nearly white.

*Canadian Forestry Service, Northern Forest Research Centre, Environment Canada, 5320 122nd Street, Edmonton, Alberta. T6H 3S5

Line detail includes: roads (5), railroads (6), oil pipelines with a width of only 30 meters (100 feet) (7), clearcut strips (8), and patches (9), and oil well sites as small as 200 meters square (10).

Forest covertypes in evidence are: coniferous (11) and hardwood (12) stands, muskeg (13), and burned-over areas (14). Coniferous forests appear dark red, hardwood forests appear red, and muskegs and burned-over areas show as light blue, yellow or white.

In the upper right-hand corner of the ERTS frame, a brown-to-purplish tone (15) is evident; this apparently is the result of many small patches of coniferous forest surrounded by water. The patches are less than the size of an ERTS resolution element and we get an averaging of water and coniferous forest.

These are only a few obvious spectral signatures and their interpretation. As one would expect, spectral signatures of all targets are subject to many changes depending on the season, phase of vegetation, and atmospheric pass.

A comparison of small-scale (1:120,000) aerial photograph with a portion of the previously discussed ERTS scene is shown in Figure 3.

ERTS imagery obtained on January 7, 1973 brings out surface relief of stream beds more clearly than the previous summer scene. The interpretation of vegetation types was not possible at this date because of the low sun angle and confused reflectance patterns, except to positively identify muskegs with low vegetation because they are covered with snow.

The following ERTS images are just to the south of the picture in Figure 2. These images cover an area upon which we had a detailed forest inventory done from small-scale false-color aerial photography. On this aerial photography it was possible to accurately identify all covertypes and to classify forests into twenty-foot height classes.

On May 14 before the poplar trees had leafed out but the grasses and herbs had greened up, Band 5 portrayed the bones of the test area. The high reflectance of the vegetation along the streams showed the drainage patterns. In addition because the aspen were without leaf areas where a dense spruce understory was present were indicated.

On September 17, 1973, Band 5 appears to be considerably different from Band 5 on May 14, 1973. This is attributed to the first frosts in fall and to the changing reflectance patterns of the poplar leaves. Considerable caution in the interpretation of vegetation using photography or satellite imagery must be exercised in the fall. Imagery at this date may indicate when killing frosts occur. In addition to rapid phenological changes in the aspen, there are phenological changes in the muskeg. Muskegs and softwood forests both have low reflectance on Band 5 in September.

Band 7 on September 17, 1973, was different from any previous Band 7 received. On this band, roads and line detail previously found only on Bands 4 and 5 now appear.

Color composites were made using a color additive viewer, Bands 4, 5 and 6 were combined with blue, green and red filters respectively. A forest burned-over in 1971 appears in the September composite, but not in the May composite. Therefore it is suggested that mapping of burned-over forest may be best done with fall imagery after the first killing frosts.

The May image indicated the location of the coniferous forest on Band 5, while Bands 4, 5, 6 of the September imagery showed the location of the hardwood forest. Therefore we combined the spring and fall imagery as follows:

Date	Band	Filter
September 17, 1973	4	Blue
" " "	5	Red
" " "	6	Green
May 14, 1973	5	Red

This combination of spectral bands and seasons gave good separation between water, conifers, muskegs and hardwood stands. In addition the location of forest cutting and road construction is enhanced. An updating of the forest cover map is possible with this type of information.

These trials illustrate that by combining phenological knowledge with the knowledge of spectral reflectance patterns the interpretation of vegetation types from ERTS imagery is improved.

A multistaged forest inventory system using satellite imagery, and aerial photography of small-scale (1:120,000) I.R. ektachrome (Kodak film 2445) and large-scale (1:1000) with aero color negative film (Kodak film 2445) is being developed.

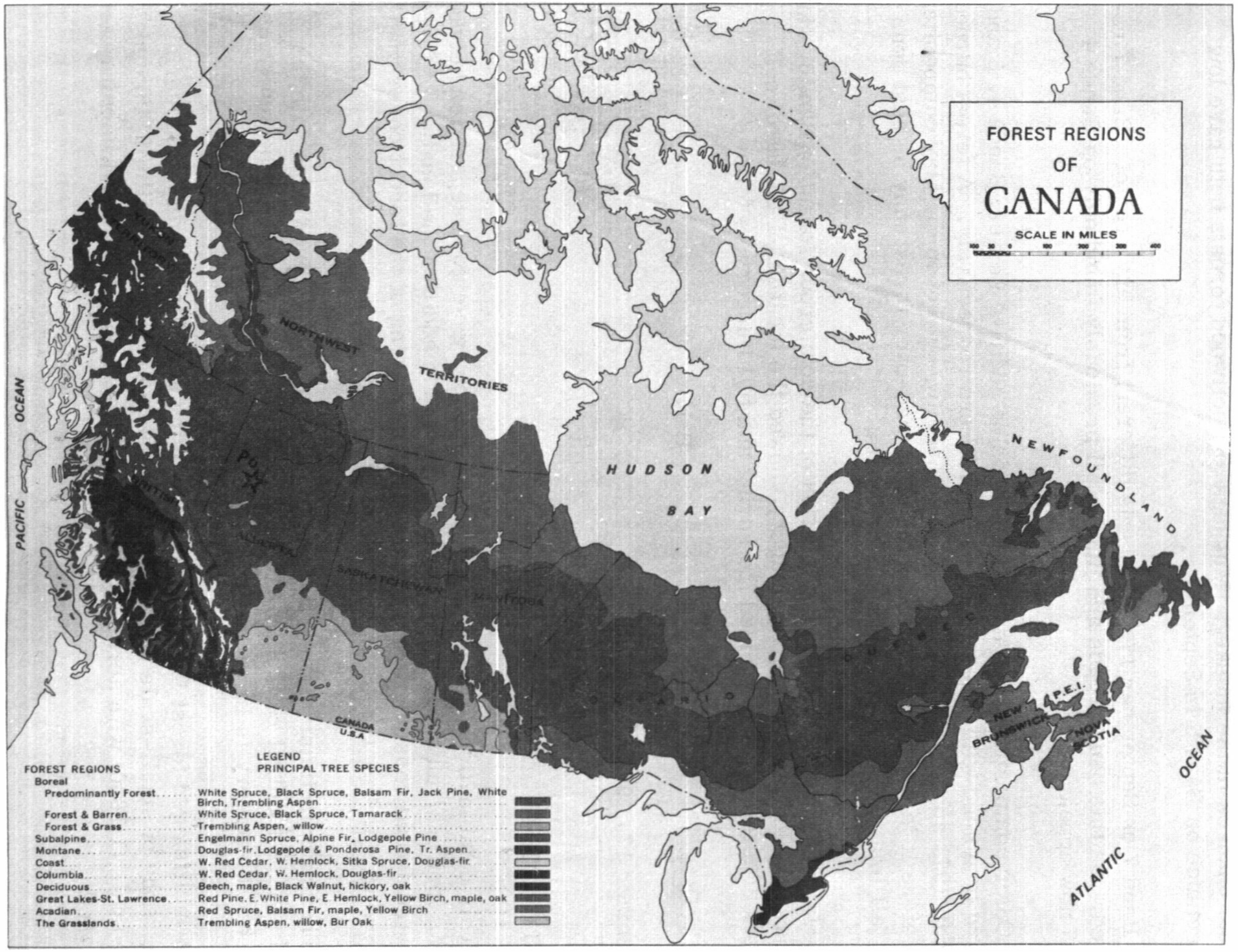


Figure 1. Location of P-6 Test Site in the Boreal Forest Region

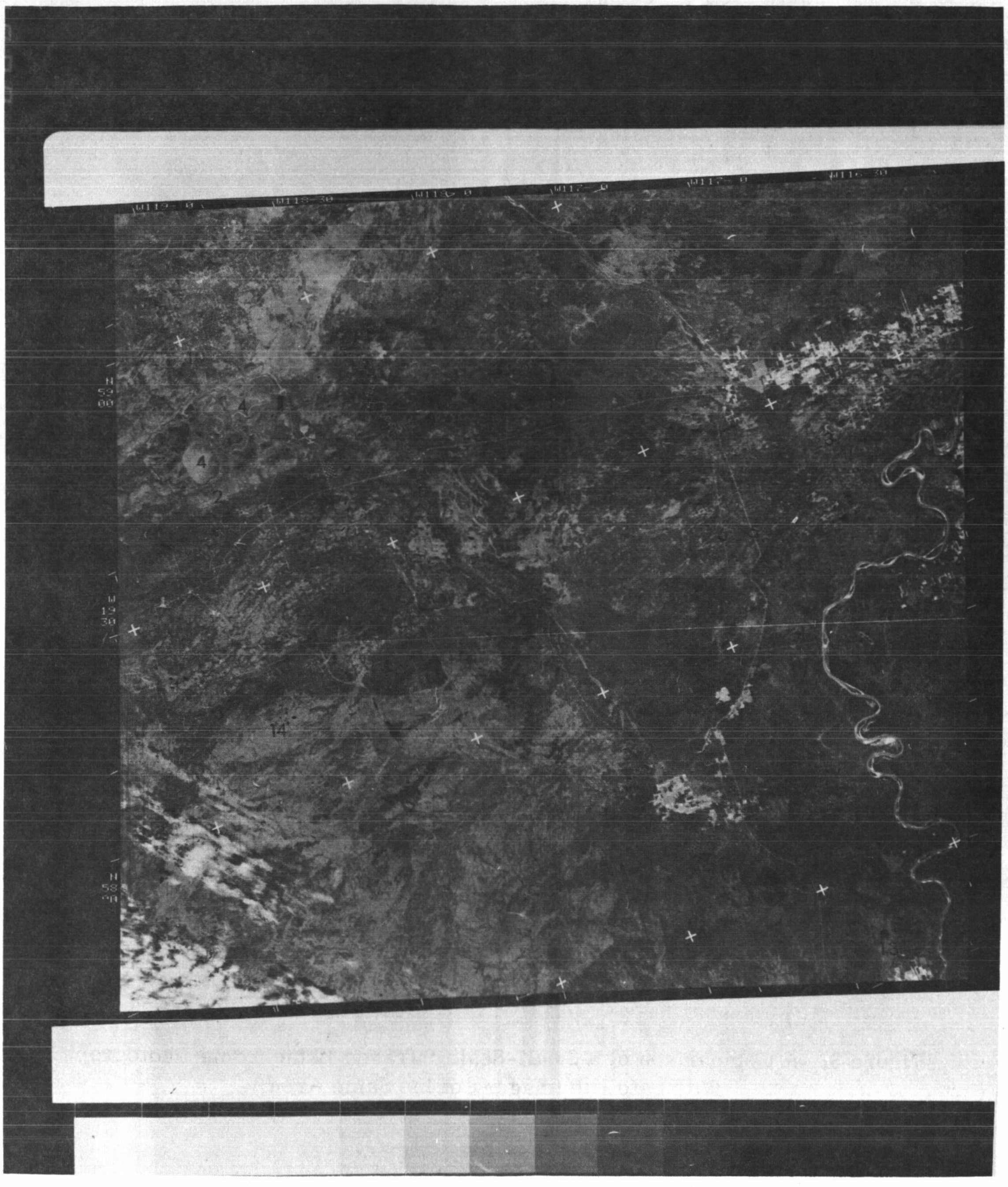
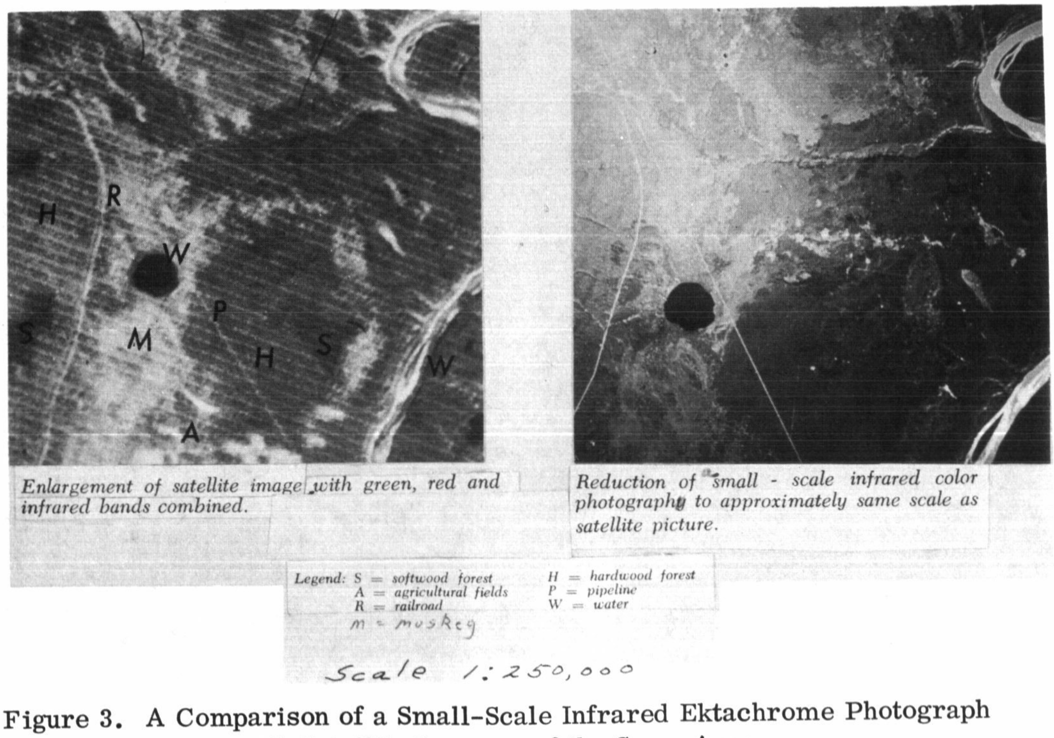


Figure 2. ERTS Image of Northwestern Alberta Obtained September 2, 1972



Enlargement of satellite image with green, red and infrared bands combined.

Reduction of small - scale infrared color photography to approximately same scale as satellite picture.

Legend: S = *softwood forest* H = *hardwood forest*
A = *agricultural fields* P = *pipeline*
R = *railroad* W = *water*
m = muskeg

Scale 1:250,000

Figure 3. A Comparison of a Small-Scale Infrared Ektachrome Photograph With Satellite Imagery of the Same Area

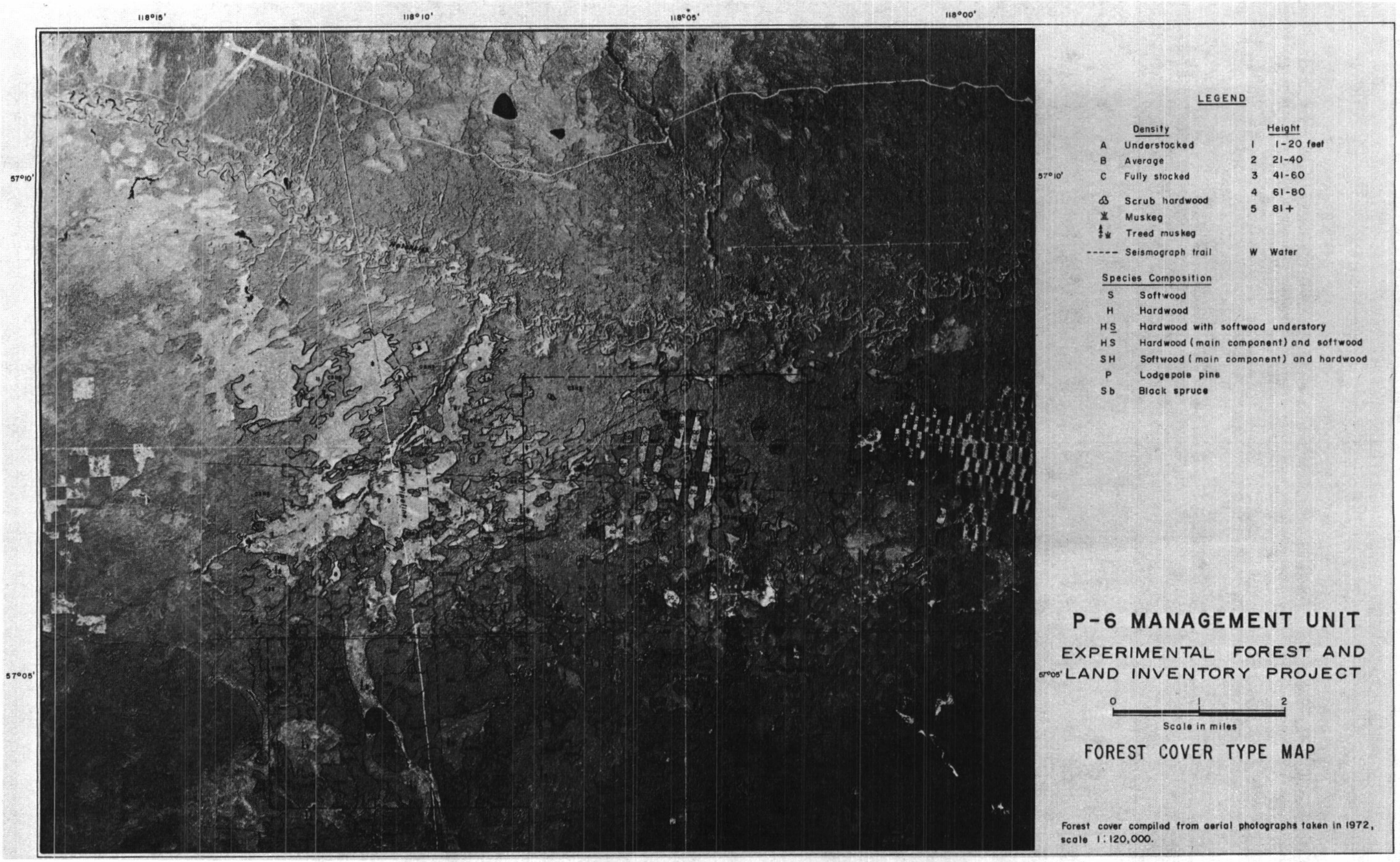


Figure 4. Forest Covertypes as an Overlay on a Small-Scale Photograph

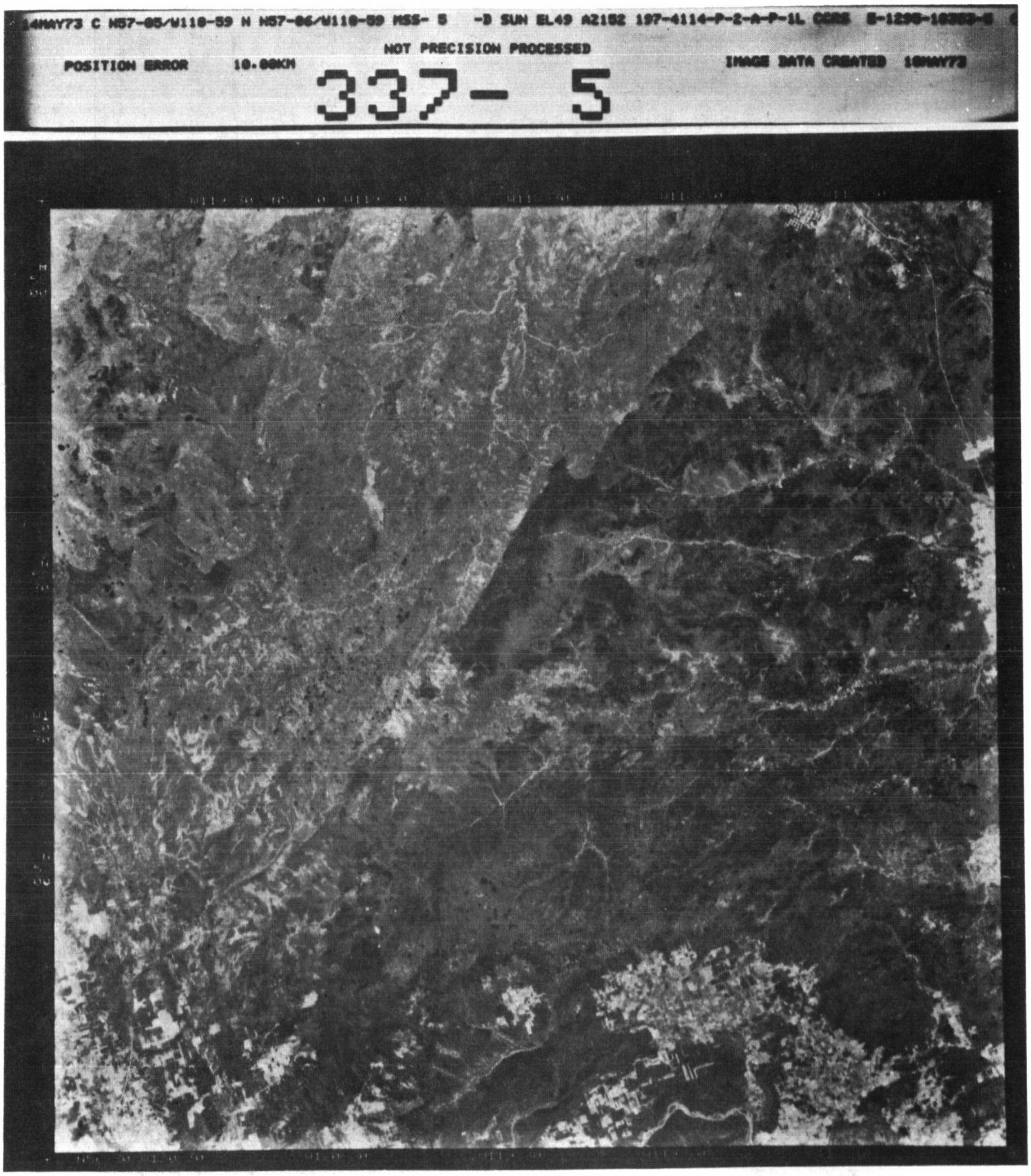


Figure 5. ERTS image Band 5, May 14, 1973.
Drainage patterns and conifercous forests are indicated.

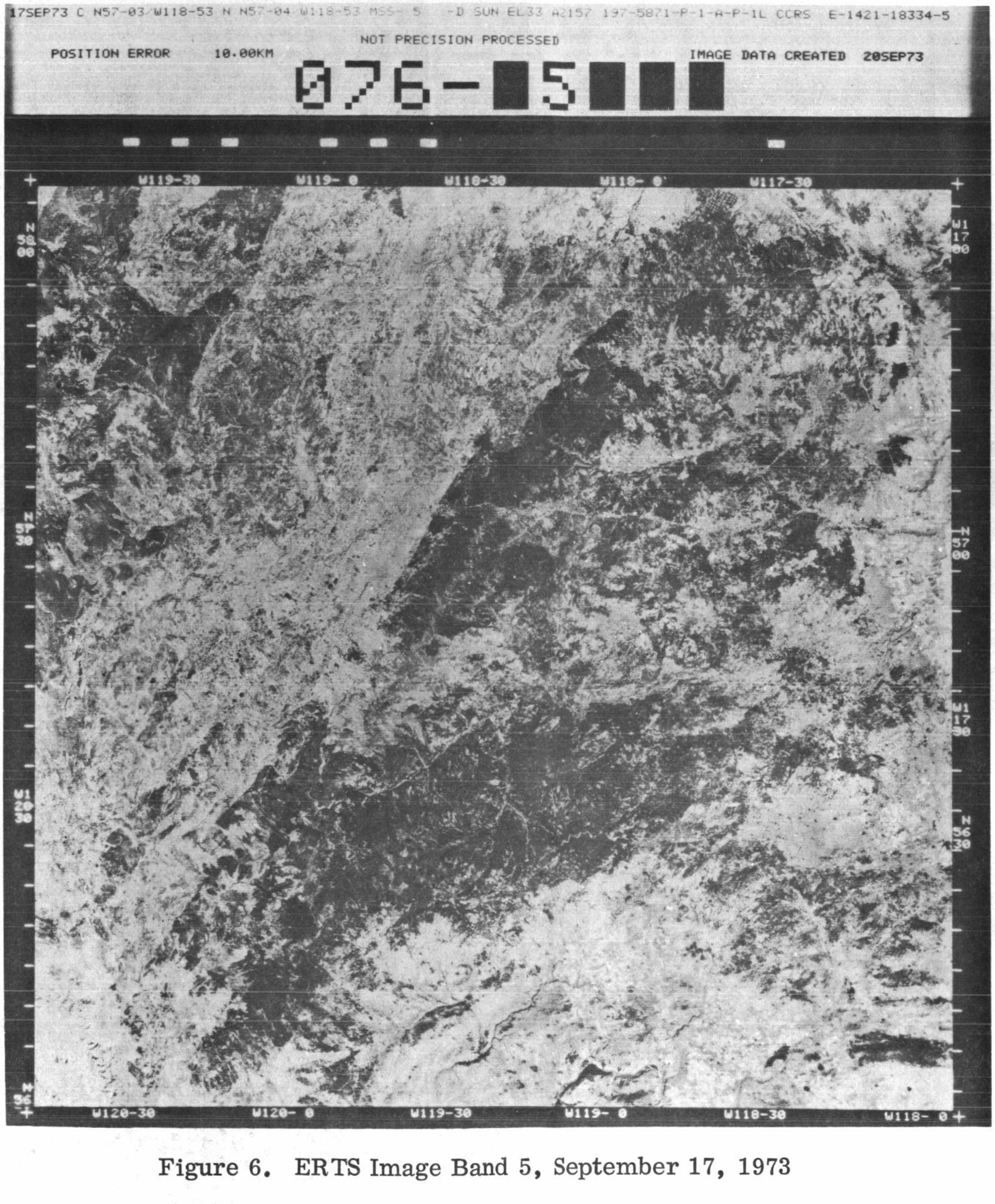


Figure 6. ERTS Image Band 5, September 17, 1973

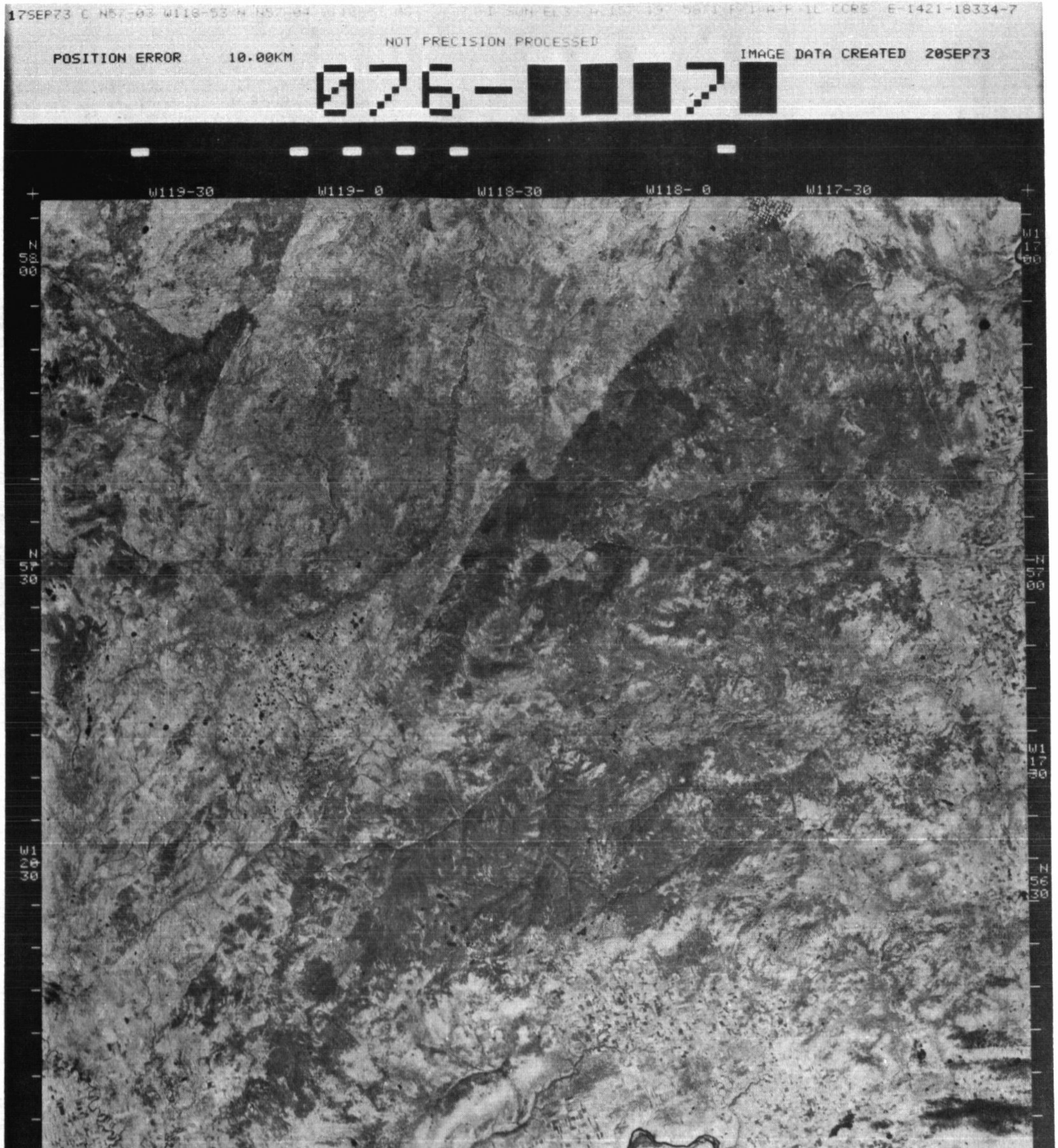


Figure 7. ERTS Image Band 7, September 17, 1973